TEST REPORT
FROM
RFI GLOBAL SERVICES LTD

Test of: Zinwave DAS3000

To: FCC Part 90: 2008
Technology - UHF

Test Report Serial No:
RFI/RPT2/RP74441JD01L

Supersedes Test Report Serial No:
RFI/RPT1/RP74441JD01L

This Test Report Is Issued Under The Authority Of Brian Watson, Operations Director:  **pp**	
Checked By: Nigel Davison 	**Report Copy No: PDF01**
Issue Date: 11 February 2009	**Test Dates: 09 December 2008**

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1. Customer Information

Company Name:	Zinwave Ltd
Address:	Harston Mill Harston Cambridge CB2 5GG

2. Equipment Under Test (EUT)

2.1. Identification of Equipment Under Test (EUT)

Brand Name:	Zinwave Ltd
Model Name or Number:	PHUB (Primary Hub)
Serial Number:	Hub06
Revision Number:	HUB-302-0001-3.10
Country of Manufacture:	England
Date of Receipt:	06 October 2008
FCC ID Number:	UPO302-0006

Brand Name:	Zinwave Ltd
Model Name or Number:	SHUB (Secondary Hub)
Serial Number:	Hub07
Revision Number:	HUB-302-0013-3.10
Country of Manufacture:	England
Date of Receipt:	06 October 2008
FCC ID Number:	UPO302-0006

Brand Name:	Zinwave Ltd
Model Name or Number:	RU (Remote Unit)
Serial Number:	310101000017
Revision Number:	302-006-1.20 + NCR 0037
FCC ID Number:	302-0007
Country of Manufacture:	England
Date of Receipt:	06 October 2008
FCC ID Number:	UPO302-0006

2.2. Description of EUT

The 3000 Hub and wideband remote unit is a bi-directional wideband distributed antenna system with a pass band of 136 – 2700 MHz currently.

2.3. Modifications Incorporated in EUT

During the course of testing the EUT was not modified.

2.4. Additional Information Related to Testing

Power Supply Requirement:	120 V AC, 60 Hz		
Intended Operating Environment:	Commercial / Light Industrial / Heavy Industrial		
Equipment Category:	Base Station		
Type of Unit:	DAS (Distributed Antenna System)		
Transmit Frequency Range:	456 MHz to 512 MHz		
Transmit Channels Tested:	**Modulation**	**Bandwidth**	**Channel Frequency (MHz)**
	C4FM (QPSK)	12.5 kHz	511.9875
	FM (2.5 kHz)	12.5	511.9875
	FM (5 kHz)	25 kHz	511.975
Maximum Power Output (EIRP)	+28.0 dBm		

2.5. Port Identification

Port	Description	Type/Length	Applicable
1	Alarm Port	9 Pin D-Connector	N
2	RS232 Port	9 Pin D-Connector	N
3	Ethernet Port	CAT5	N
4	2 x USB Ports	USB	N
5	4 x Service Ports (I/O)	N-Type	N
6	12 x Optical Module Ports (I/O)	Fibre Optic Connectors	N
7	8 x RU Coax Drive (I/O)	N-Type	N

3.Test Specification, Methods and Procedures

Reference:	FCC Part 90: 2007 (Subpart B)
Title:	Code of Federal Regulations Part 90: Public Safety Radio Pool

3.1. Methods and Procedures

The methods and procedures used were as detailed in:

ANSI/TIA-603-B-2003
Land Mobile Communications Equipment, Measurements and performance Standards

ANSI C63.2 (1987)
Title: American National Standard for Instrumentation - Electromagnetic noise and field strength.

ANSI C63.4 (2003)
Title: American National Standard Methods of Measurement of Electromagnetic Emissions from Low Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

ANSI C63.5 (1988)
Title: American National Standard for the Calibration of antennas used for Radiated Emission measurements in Electromagnetic Interference (EMI) control.

ANSI C63.7 (1988)
Title: American National Standard Guide for Construction of Open Area Test Sites for performing Radiated Emission Measurements.

CISPR 16-1: (1999)
Title: Specification For Radio Disturbance and Immunity Measuring Apparatus and Methods. Part 1: Radio Disturbance and Immunity Measuring Apparatus.

3.2. Definition of Measurement Equipment

The measurement equipment used complied with the requirements of the standards referenced in the methods & procedures section above. Appendix 1 contains a list of the test equipment used.

4. Deviations from the Test Specification

The testing has been performed in accordance with the following Project Plan:

Project Plan for DheaniSulis – End Customer Zinwave Ltd
American TCB Project Number: ATCB006596
Date of Issue: 01 October 2008

5. Operation of the EUT during Testing

5.1. Operating Modes

The EUT was tested in the following operating modes, unless otherwise stated.

- Please see section 5.2 – Configuration and Peripherals

5.2. Configuration and Peripherals

The EUT was tested in the following configurations/modes unless otherwise stated:

- The EUT comprises of 3 separate units. Primary Hub, Secondary Hub and the Remote Unit. The primary hub was connected to the secondary hub via fibre optic cables. The secondary hub was connected to the remote unit via coaxial cables. An input signal was fed into the primary hub and was measured from the antenna output port of the remote unit. The remote unit was operating at maximum output power with the maximum gain settings allowed through the system.

- For radiated emissions testing, 4 CW signals were connected to the separate input ports of the EUT. The levels were adjusted to give a composite signal output level of +20.0 dBm. The antenna port on the remote unit was terminated for this test.

- For conducted tests, 1– 4 input signals were connected to the EUT. Depending on the test case, either a CW or a modulated signal was fed into the primary hub with the measurement being made on the antenna port of the remote unit. Each of the modulated signals listed in section 2.4 were tested.

- For Occupied Bandwidth tests, the test was first performed on the output of the modulated signal before inputting into the EUT (input signal). Next the signal was measured at the antenna port output on the remote unit (output signal). After the measurements were completed, the results were compared and verified that the signal bandwidth had not altered through the system.

- For Transmitter AC Conducted Emissions testing, measurements were only performed on the secondary hub as this provided the power source for the remote unit. The system was configured as for radiated emissions testing.

6. Summary of Test Results

Range of Measurements	Specification Reference	Port Type	Result
Transmitter AC Conducted Spurious Emissions (150 kHz to 30 MHz)	C.F.R. 47 FCC Part 15 Section 15.207	AC Mains Input	Complied
Transmitter Carrier Output Power	C.F.R. 47 FCC Part 90 Sections 90.205 TIA-603-B Section 2.2.1	Antenna Terminals	Complied
Transmitter Frequency Stability (Temperature Variation)	C.F.R. 47 FCC Part 90 Sections 90.213/2.1055 TIA-603-B Section 2.2.2	Antenna Terminals	Complied
Transmitter Frequency Stability (Voltage Variation)	C.F.R. 47 FCC Part 90 Sections 90.213/2.1055 TIA-603-B Section 2.2.2	Antenna Terminals	Complied
Transmitter Occupied Bandwidth	C.F.R. 47 FCC Part 90 Sections 90.209/2.1049	Antenna Terminals	Complied
Gain Flatness and Out of Band Rejection	Project Plan: ATCB006596	Antenna Terminals	Complied (note 1)
Inter-Modulation Attenuation	Project Plan: ATCB006596	Antenna Terminals	Complied (note 1)
Transmitter Out of Band Conducted Emissions	C.F.R. 47 FCC Part 90 Sections 90.210 TIA-603-B Section 2.2.13	Antenna Terminals	Complied
Transmitter Out of Band Radiated Emissions	C.F.R. 47 FCC Part 90 Sections 90.210 TIA-603-B Section 2.2.12	Antenna	Complied

Note 1: These tests are not required within the Part 90 regulations. However they were defined within the referenced project plan.

6.1. Location of Tests

All the measurements described in this report were performed at the premises of RFI Global Services Ltd, Wade Road, Basingstoke, Hampshire, RG24 8AH.

6.2. Site Registration Number

FCC: 209735

7. Measurements, Examinations and Derived Results

7.1. General Comments

This section contains test results only.

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to section 8 for details of measurement uncertainties.

It is stated in ATCB plan ATCB006596 pages 12 and 13 that if the modulation bandwidth as measured at the EUT output varies very little with regards the bandwidth measured at the input then no band edge measurements' would be required. It can be seen from the data in this report that there was next to no difference between the input/output signals and as such there are no band edge measurements in this report. Also, it should be noted that as there is very little difference between input and output signals that proof is shown that there is no degradation of the original signal by the EUT and as such no spectrum mask testing is required.

Due to the nature of the device, the tightest limits for the band of operation were applied for results shown in this report.

7.2. Test Results

7.2.1. Transmitter AC Conducted Spurious Emissions: Section 15.207

The EUT was configured as for AC conducted emission measurements as described in section 9 of this report.

Tests were performed to identify the maximum emission levels present on the ac mains line of the EUT.

Results: Secondary Hub

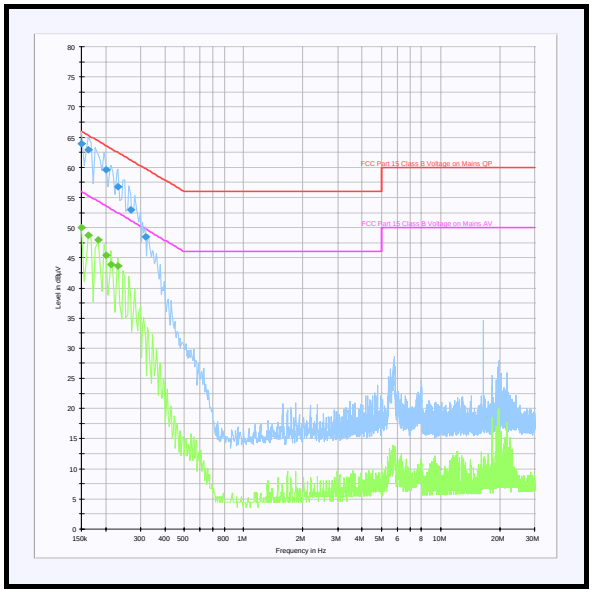
Quasi-Peak Detector Measurements on Live and Neutral Lines

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.150000	Live 1	63.9	66.0	2.1	Complied
0.163500	Live 1	62.9	65.3	2.4	Complied
0.199500	Live 1	59.6	63.6	4.0	Complied
0.231000	Live 1	56.7	62.4	5.7	Complied
0.267000	Neutral	53.0	61.2	8.2	Complied
0.316500	Live 1	48.5	59.8	11.3	Complied

Average Detector Measurements on Live and Neutral Lines

Frequency (MHz)	Line	Level (dBµV)	Limit (dBµV)	Margin (dB)	Result
0.150000	Neutral	50.0	56.0	6.0	Complied
0.163500	Neutral	48.7	55.3	6.6	Complied
0.181500	Neutral	48.0	54.4	6.4	Complied
0.199500	Live 1	45.5	53.6	8.1	Complied
0.213000	Live 1	43.8	53.1	9.3	Complied
0.231000	Neutral	43.7	52.4	8.7	Complied

Receiver/Idle Mode AC Conducted Spurious Emissions: Section 15.107 (continued)



Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying tables.

Note(s):

1. *The following CW test signals were used throughout this test: Port 1 = 200 MHz; Port 2 = 1 GHz; Port 3 = 2 GHz; Port 4 = 2.7 GHz*

7.2.2. Transmitter Carrier Output Power: Section 90.205

The EUT was configured as for conducted RF output power as described in section 9 of this report.

Tests were performed to identify the EUT's maximum conducted transmit power.

Results:

Technology	Frequency (MHz)	Conducted RF O/P Power (dBm)	Declared Antenna Gain (dBi)	EIRP (dBm)	EIRP Limit (dBm)	Margin (dB)	Result
C4FM (QPSK)	511.9975	20.0	8.0	28.0	32.2	4.2	Complied
FM (5 kHz)	511.975	20.0	8.0	28.0	32.2	4.2	Complied

Note(s):

1. *Measurements were performed with a power sensor and meter.*

2. *The limit in FCC Part 90 is in reference to an ERP limit. Due to the nature of the equipment, the client has declared an EIRP and as such, the ERP limit has been converted to EIRP by adding 2.2 dB.*

7.2.3. Transmitter Frequency Stability (Temperature Variation): Section 90.213 / 2.1055

The EUT was configured as for frequency stability measurements as described in section 9 of this report.

Tests were performed to identify the maximum frequency error of the EUT with variations in ambient temperature.

Results:

510 MHz - CW

Temperature (°C)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)	Limit (ppm)	Margin (ppm)	Result
-30	-	-	-	2.5	-	Complied
-20	-	-	-	2.5	-	Complied
-10	510.000000	0	0	2.5	2.5	Complied
0	510.000000	0	0	2.5	2.5	Complied
10	510.000000	0	0	2.5	2.5	Complied
20	510.000001	1	0	2.5	2.5	Complied
30	510.000001	1	0	2.5	2.5	Complied
40	510.000000	0	0	2.5	2.5	Complied
50	510.000000	0	0	2.5	2.5	Complied

Note(s):

1. *The EUT would not function at this temperature. The EUT was seen to comply right up to the point the EUT ceased to function.*

7.2.4. Transmitter Frequency Stability (Voltage Variation): Section 90.213 / 2.1055

The EUT was configured as for frequency stability measurements as described in section 9 of this report.

Tests were performed to identify the maximum frequency error of the EUT with variations in nominal operating voltage.

Results:

510 MHz - CW

Supply Voltage (V)	Measured Frequency (MHz)	Frequency Error (Hz)	Frequency Error (ppm)	Limit (ppm)	Margin (ppm)	Result
102.0	510.000000	0	0	2.5	2.5	Complied
138.0	510.000000	0	0	2.5	2.5	Complied

7.2.5. Transmitter Occupied Bandwidth: Section 90.209

The EUT was configured as for occupied bandwidth measurements as described in section 9 of this report.

Tests were performed to identify the maximum bandwidth occupied by the fundamental frequency of the EUT. The 99% occupied bandwidth was measured using the channel bandwidth function of the R&S spectrum analyser.

It can be seen that the input and output signals are identical and thus in accordance with ATCB 006596 Pg 12/13 test plan deemed sufficient to demonstrate band edge compliance.

Input Signal

Technology	Frequency (MHz)	Resolution Bandwidth (kHz)	Video Bandwidth (kHz)	Occupied Bandwidth (kHz)
C4FM (QPSK)	511.9875	1.0	10.0	9.078
FM (2.5 kHz)	511.9875	1.0	10.0	8.116
FM (5 kHz)	511.975	1.0	10.0	13.467

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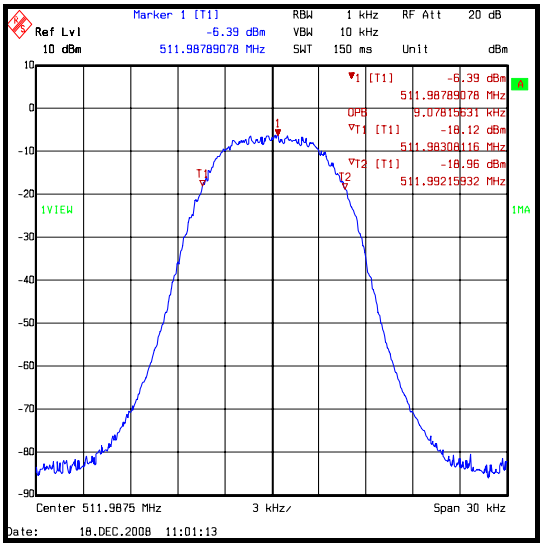
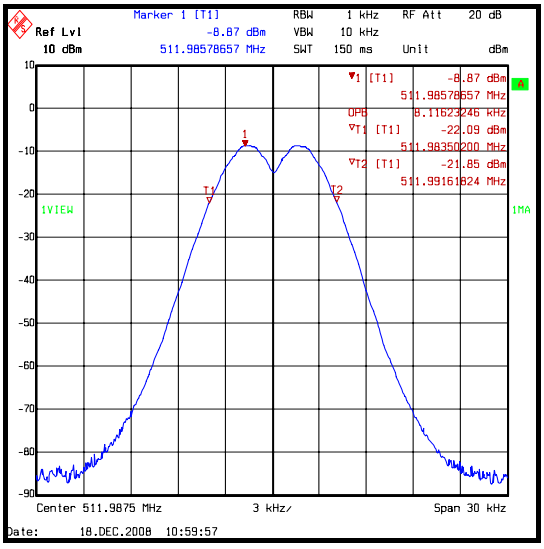
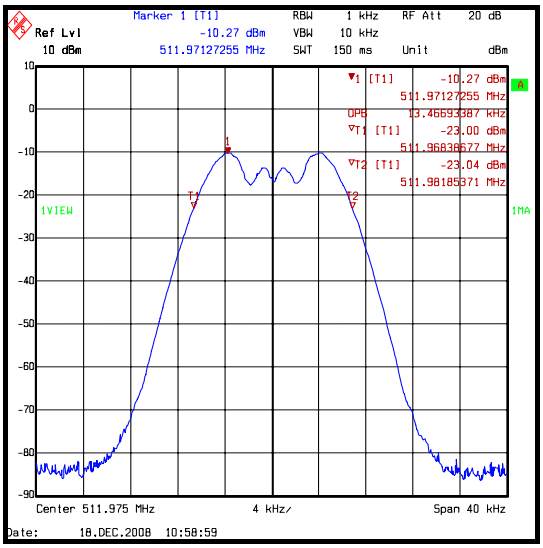
Transmitter Occupied Bandwidth: Section 90.209(continued)



C4FM (QPSK)



FM (2.5 kHz)



FM (5.0 kHz)

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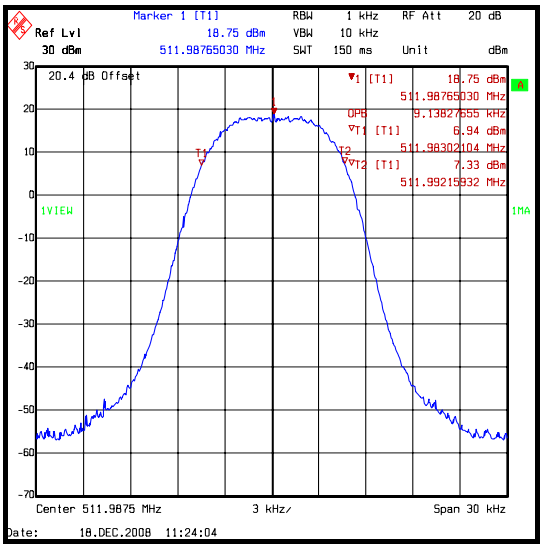
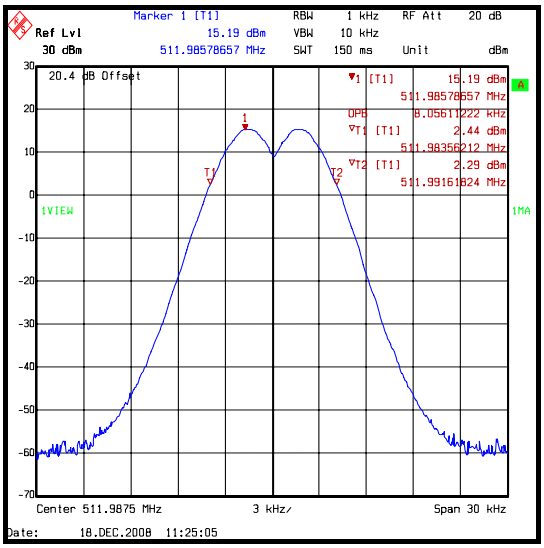
Transmitter Occupied Bandwidth: Section 90.209(continued)

Output Signal

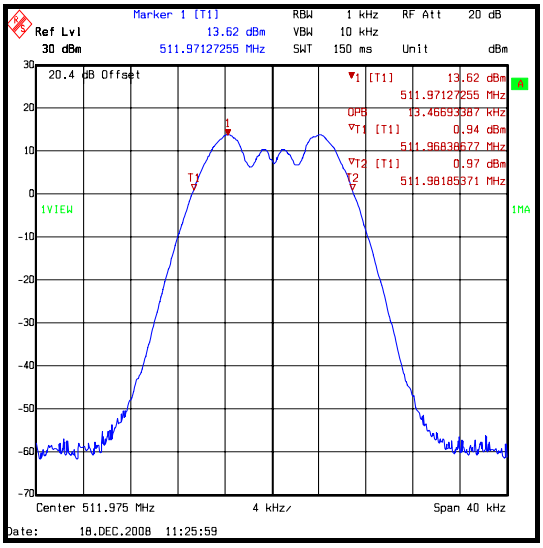
Technology	Frequency (MHz)	Resolution Bandwidth (kHz)	Video Bandwidth (kHz)	Occupied Bandwidth (kHz)
C4FM (QPSK)	511.9875	1.0	10.0	9.138
FM (2.5 kHz)	511.9875	1.0	10.0	8.056
FM (5 kHz)	511.975	1.0	10.0	13.467



C4FM (QPSK)



FM (2.5 kHz)



FM (5.0 kHz)

7.2.6. Gain Flatness and Out of Band Rejection

This test case was performed in accordance with the Project Plan referenced in Section 4 of this report. The test was performed using a network analyser.

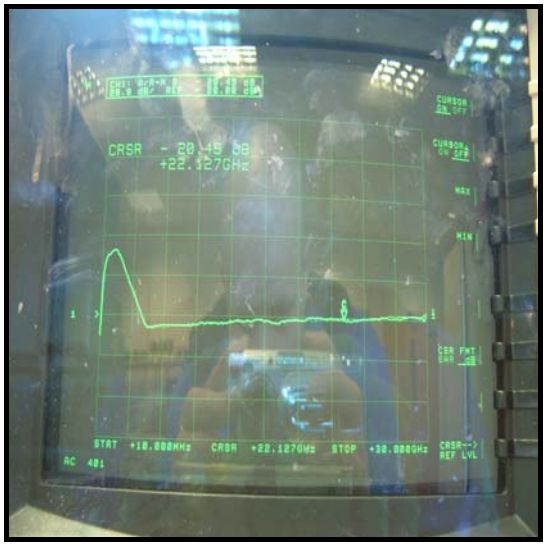
Results:

Maximum Gain Error (dB)	Limit (dB)	Margin (dB)	Result
9.2	10.0	0.8	Complied

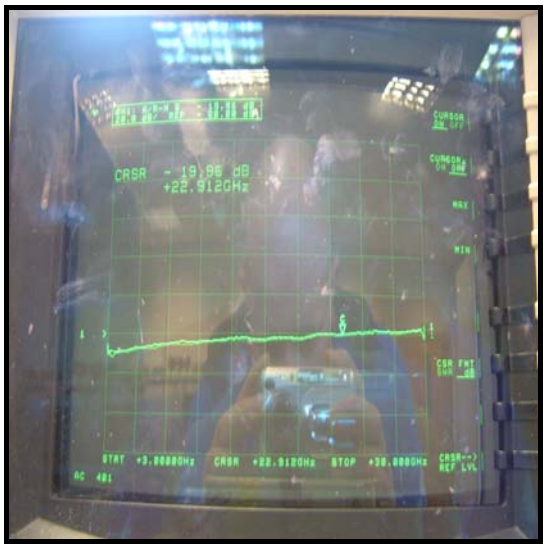
Gain Flatness and Out of Band Rejection (continued)

Gain flatness

The flat portion of the above plot shows the maximum deviation to be within 10dB (+/-5dB)



In-Band and Out of Band response – for info



Zoomed in out of band plot indicating no responses.

7.2.7. Inter-modulation Attenuation

This test case was performed in accordance with the Test Plan referenced in Section 4 of this report. The test was performed using the CW signals operating at the frequencies defined as F1 & F2

Results:

F1 = 180 MHz
F2 = 2500 MHz

Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
360.002	-17.8	-13.0	4.8	Complied
539.998	-19.5	-13.0	6.5	Complied
1959.875	-30.5	-13.0	17.5	Complied
2140.050	-26.8	-13.0	13.8	Complied
2320.025	-17.3	-13.0	4.3	Complied
2680.070	-14.5	-13.0	1.5	Complied
2860.133	-31.2	-13.0	28.2	Complied

F1 = 406 MHz
F2 = 406.0125 MHz

Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
405.975	-28.0	-13.0	15.0	Complied
405.988	-23.5	-13.0	12.5	Complied
406.025	-23.2	-13.0	10.2	Complied
406.037	-28.0	-13.0	15.0	Complied
812.000	-16.2	-13.0	3.2	Complied
1218.075	-25.2	-13.0	12.2	Complied
1624.033	-21.3	-13.0	8.3	Complied
2030.058	-21.7	-13.0	8.7	Complied
2436.150	-19.5	-13.0	6.5	Complied

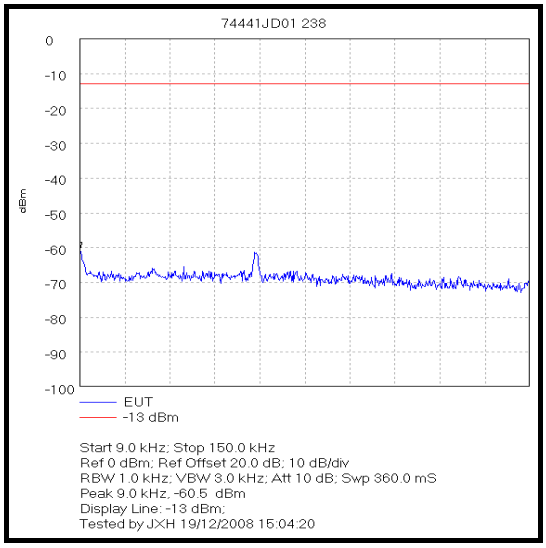
Inter-modulation Attenuation (continued)

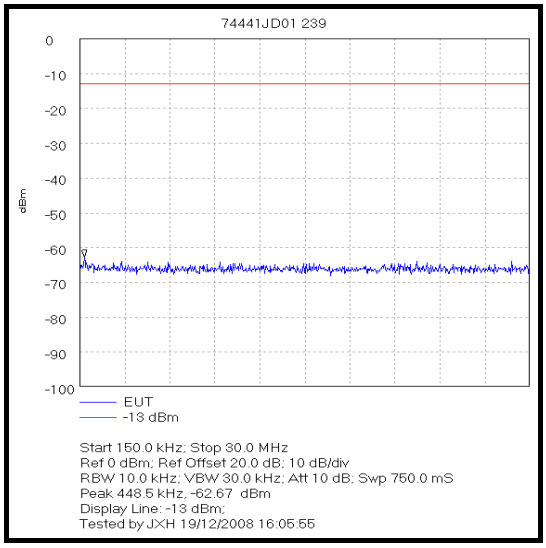
F1 = 2467 MHz
F2 = 2472 MHz

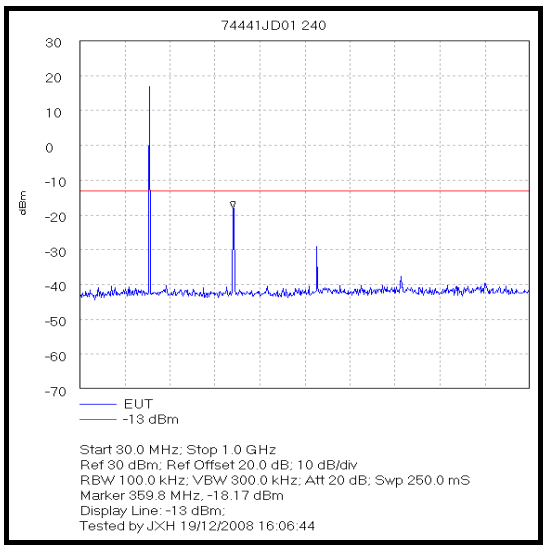
Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
2457.000	-28.0	-13.0	15.0	Complied
2462.000	-14.7	-13.0	1.7	Complied
2477.000	-14.2	-13.0	1.2	Complied
2482.000	-28.2	-13.0	15.2	Complied

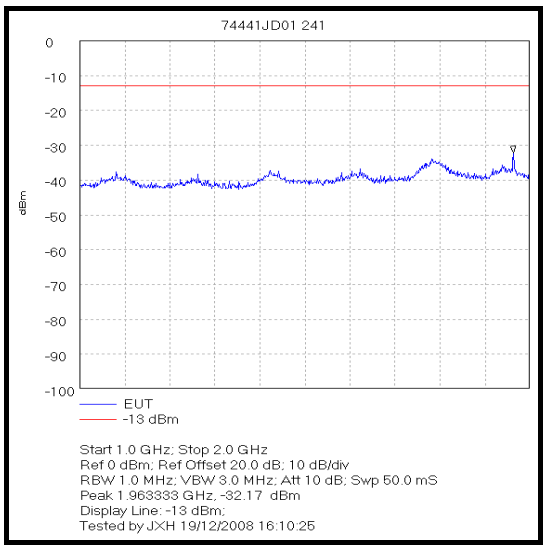
Inter-modulation Attenuation (continued)

F1 = 180 MHz
F2 = 2500 MHz





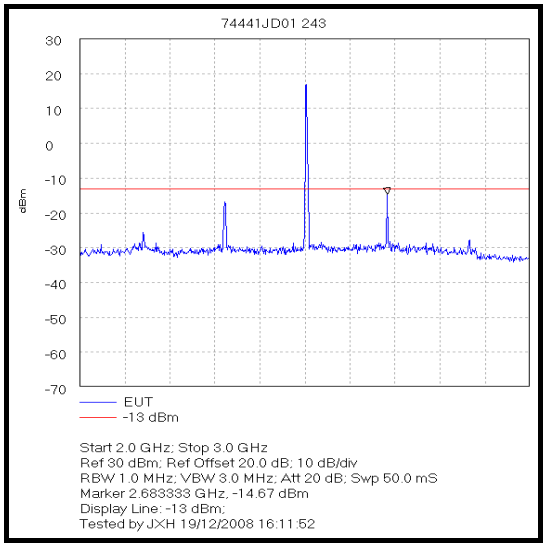


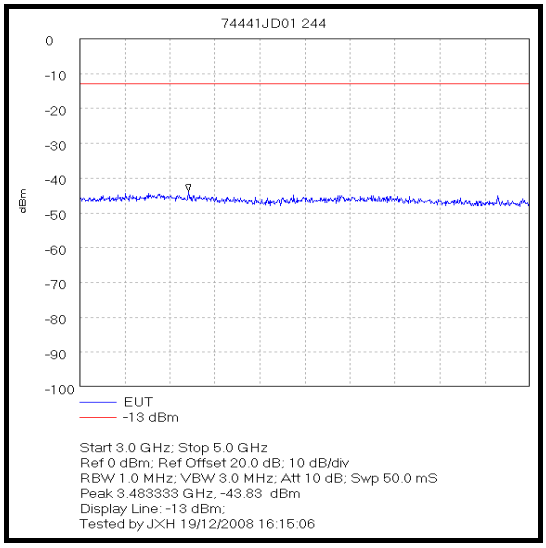


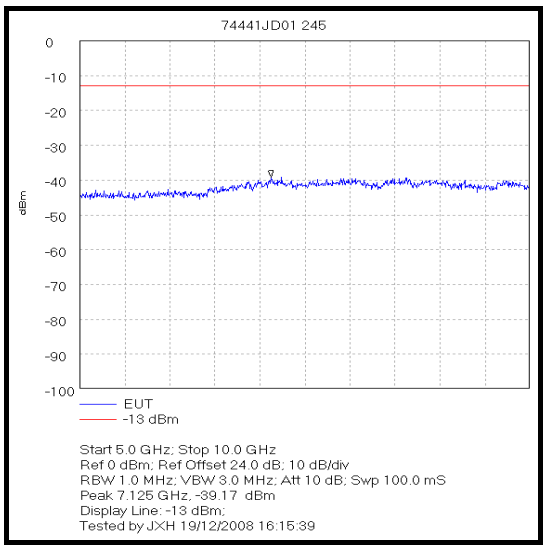
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

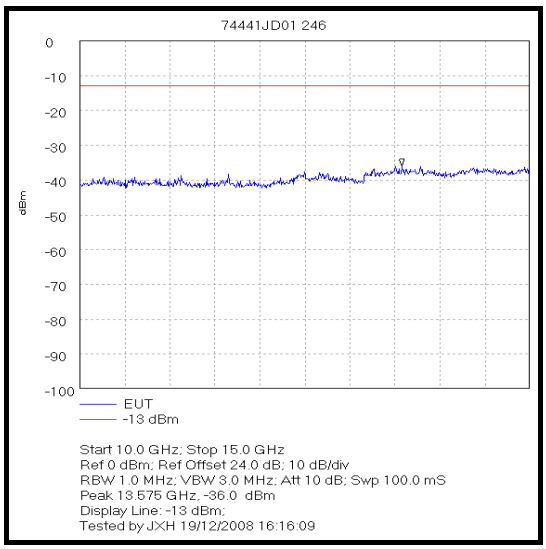
Inter-modulation Attenuation (continued)

F1 = 180 MHz
F2 = 2500 MHz





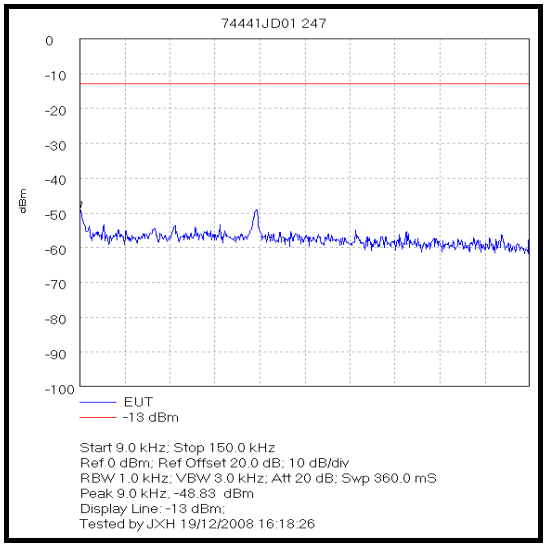


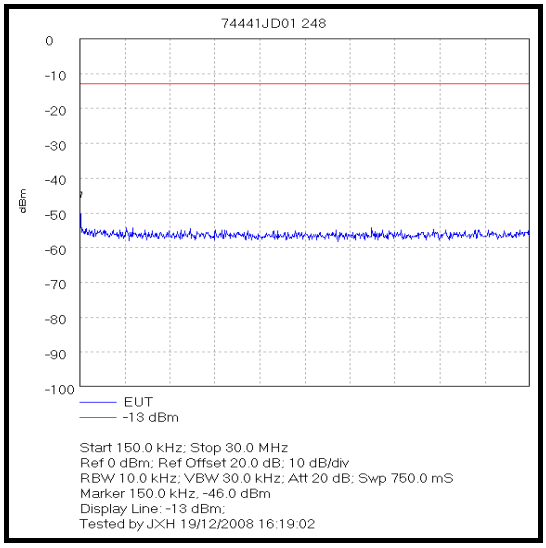


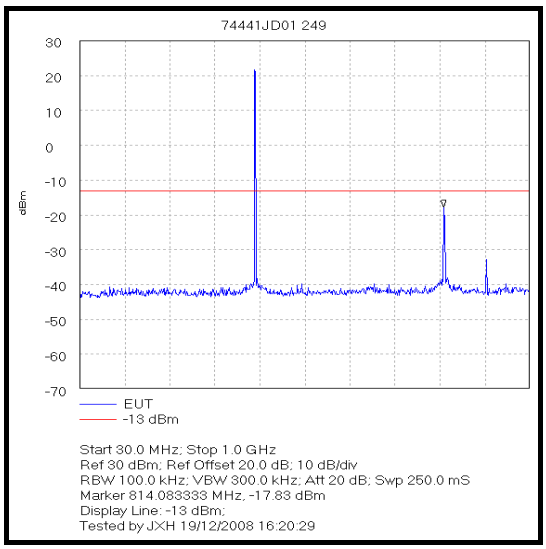
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

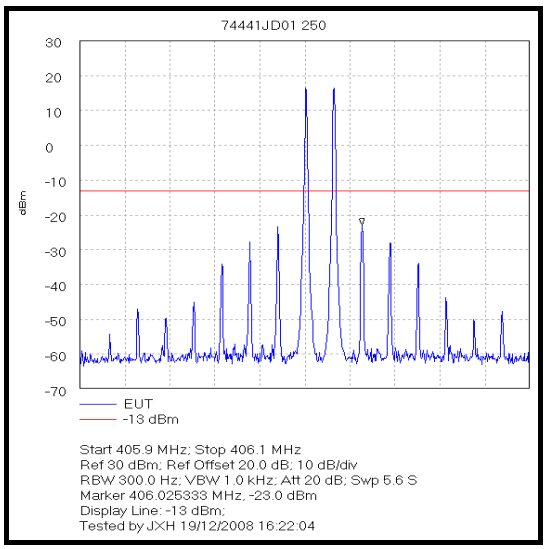
Inter-modulation Attenuation (continued)

F1 = 406 MHz
F2 = 406.0125 MHz





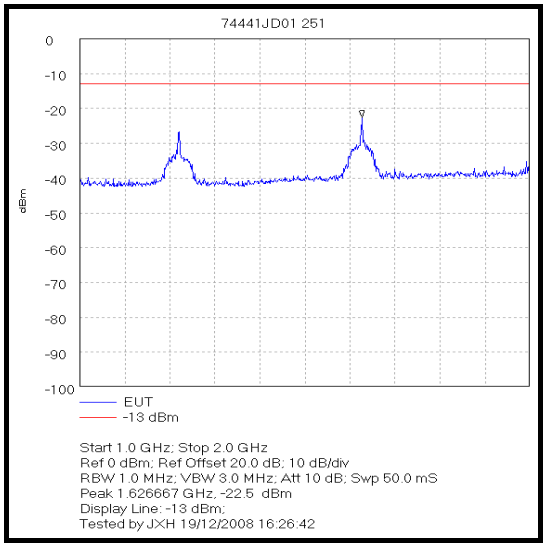


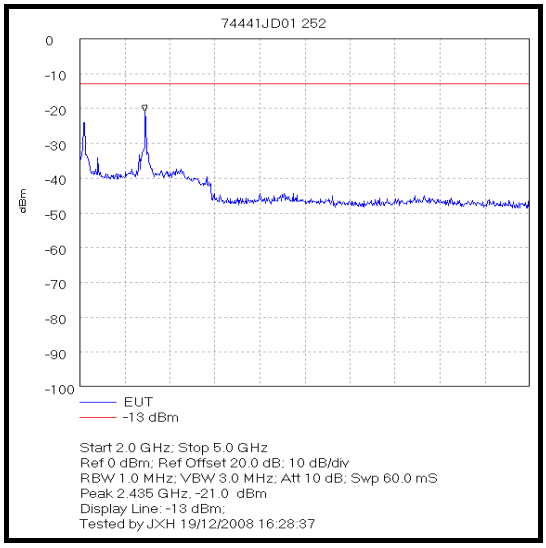


Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Inter-modulation Attenuation (continued)

F1 = 406 MHz
F2 = 406.0125 MHz

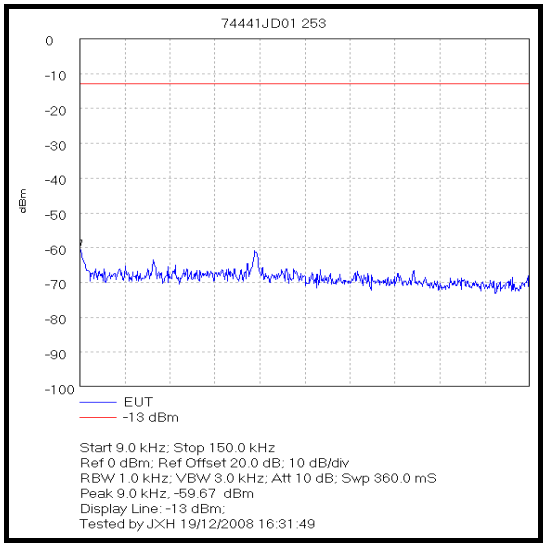


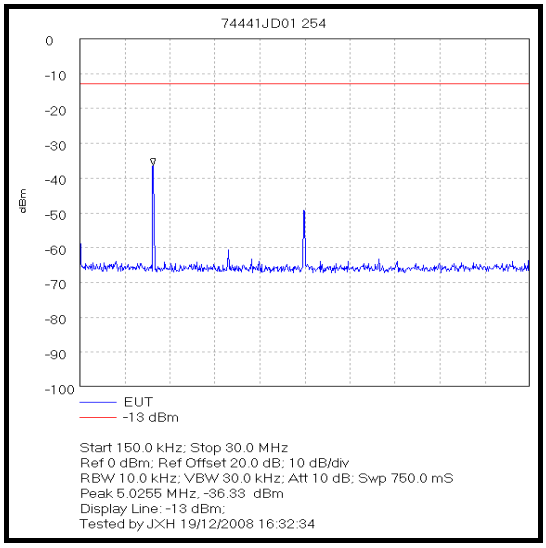


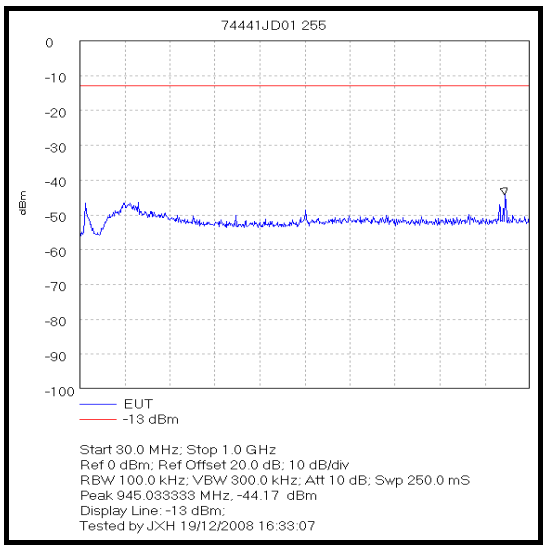
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

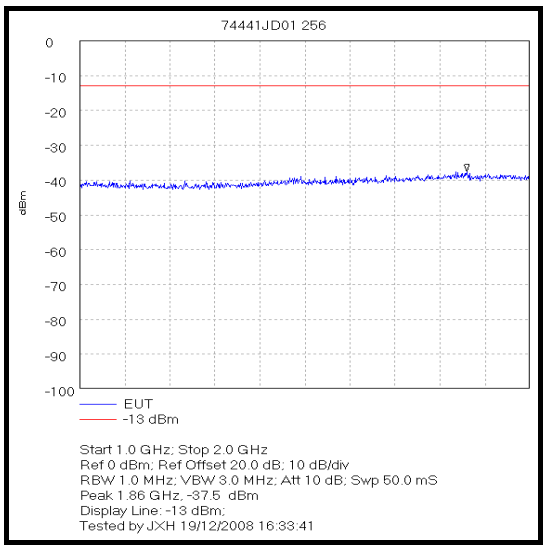
Inter-modulation Attenuation (continued)

F1 = 2467 MHz
F2 = 2472 MHz





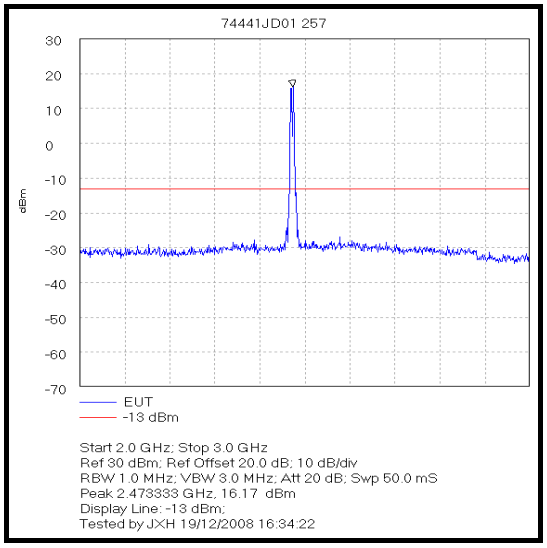


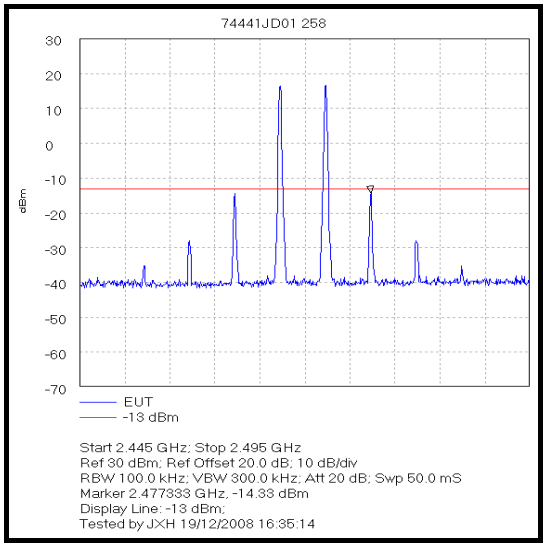


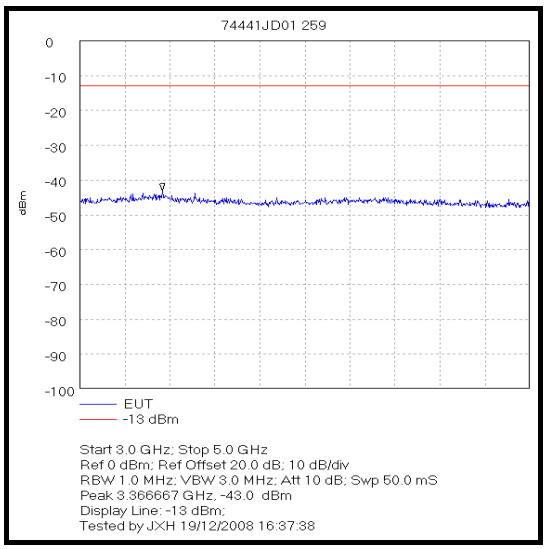
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

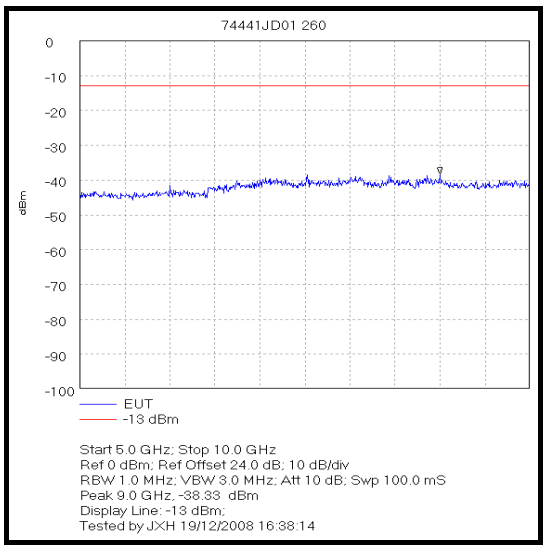
Inter-modulation Attenuation (continued)

F1 = 2467 MHz
F2 = 2472 MHz





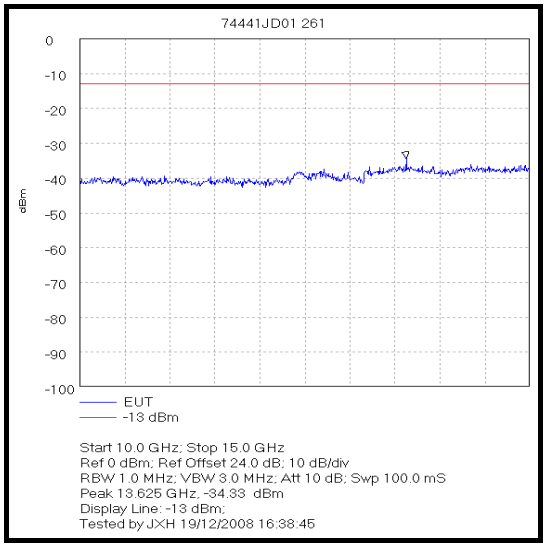




Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Inter-modulation Attenuation (continued)

F1 = 2467 MHz
F2 = 2472 MHz



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

7.2.8. Transmitter Out of Band Conducted Emissions: Section 90.210

The EUT was configured as for transmitter conducted emission measurements as described in section 9 of this report.

Tests were performed to identify the maximum transmitter conducted emission levels.

Results:

C4FM (QPSK)

Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
1024.330	-19.7	-13.0	6.7	Complied
1535.920	-22.8	-13.0	9.8	Complied
2048.300	-24.2	-13.0	11.2	Complied
2560.500	-23.5	-13.0	10.5	Complied

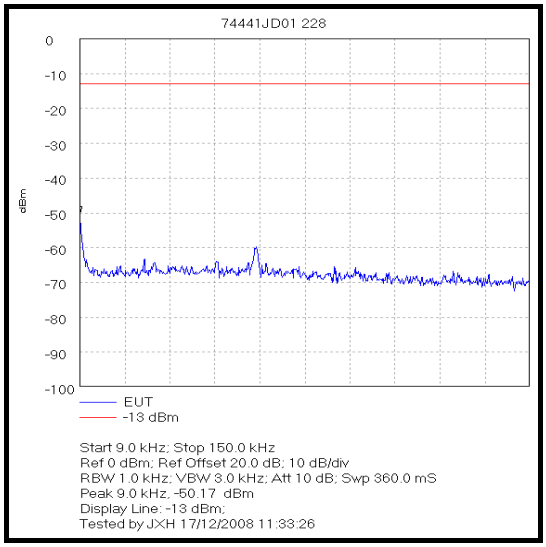
FM (5 kHz)

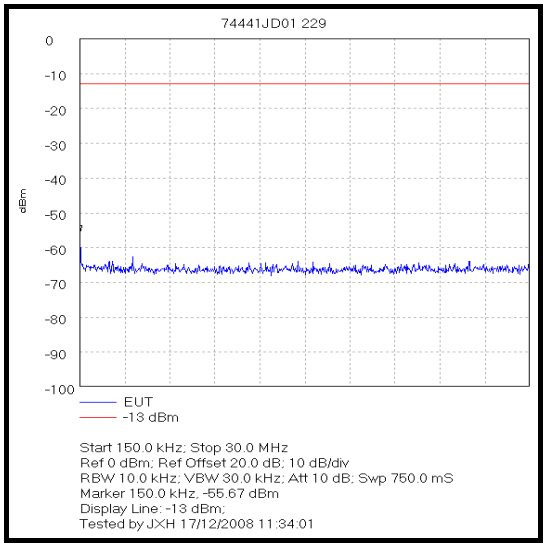
Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
1024.150	-20.0	-13.0	7.0	Complied
1535.870	-23.2	-13.0	10.2	Complied
2048.000	-28.3	-13.0	15.2	Complied
2560.300	-28.0	-13.0	15.0	Complied

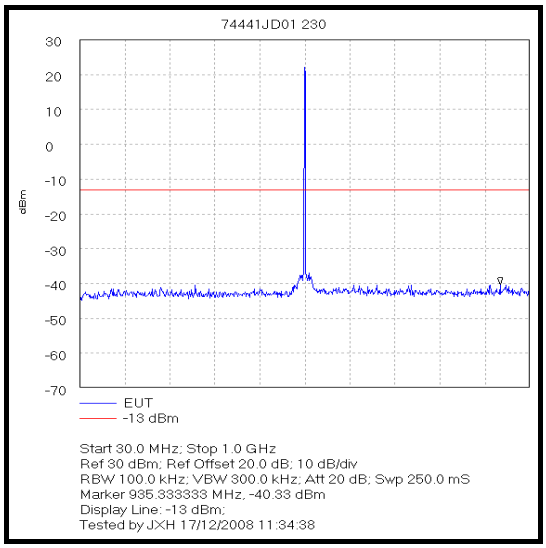
Note(s):

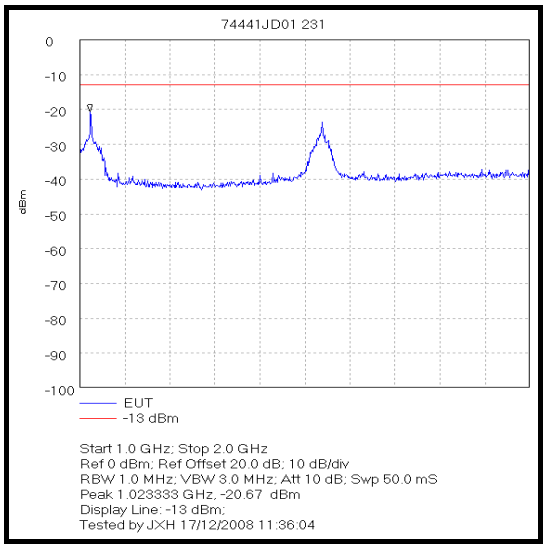
1. All other emissions were at least 20 dB below the limit.

Transmitter Out of Band Conducted Emissions: Section 90.210 (continued) – C4FM (QPSK)



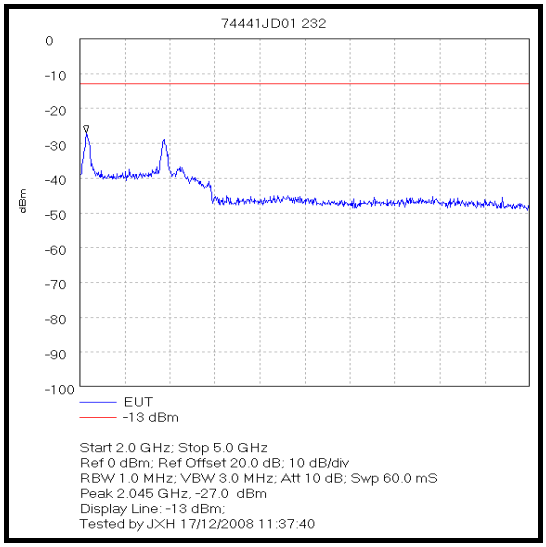


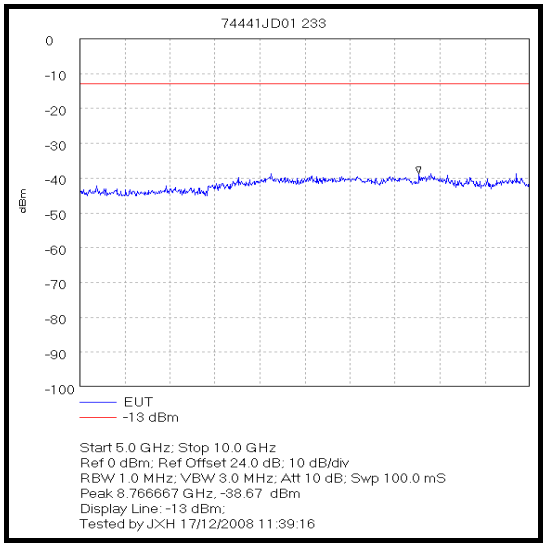


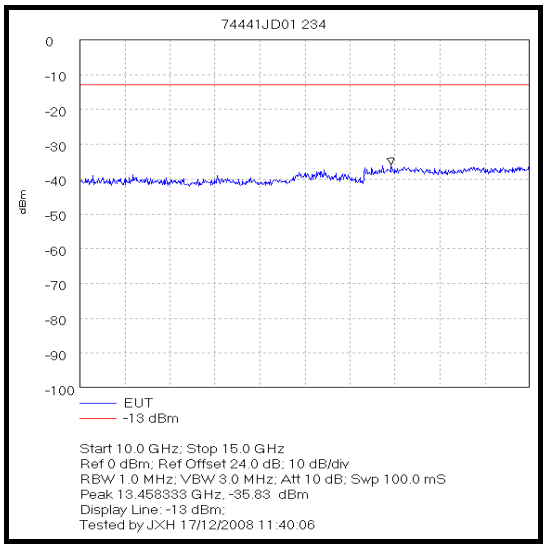


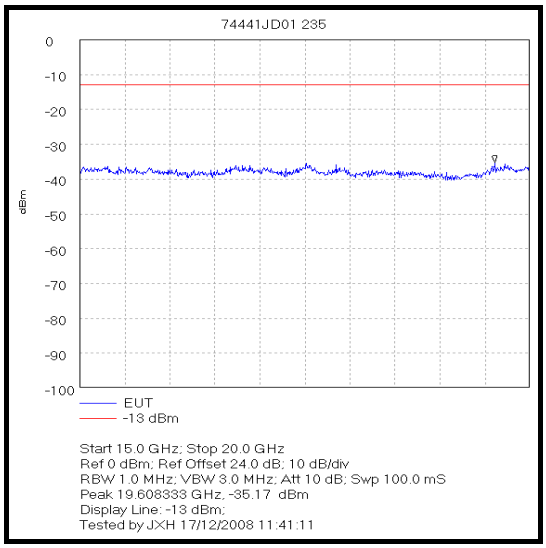
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Out of Band Conducted Emissions: Section 90.210 (continued) – C4FM (QPSK)



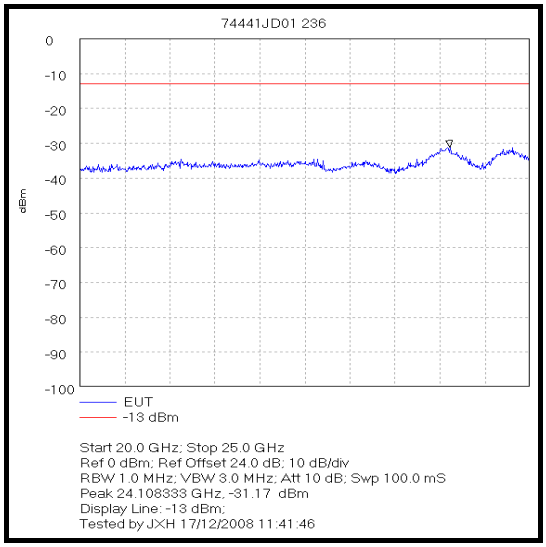


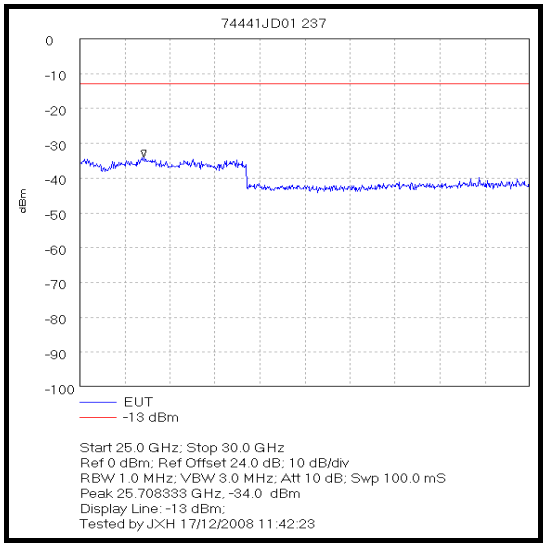




Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

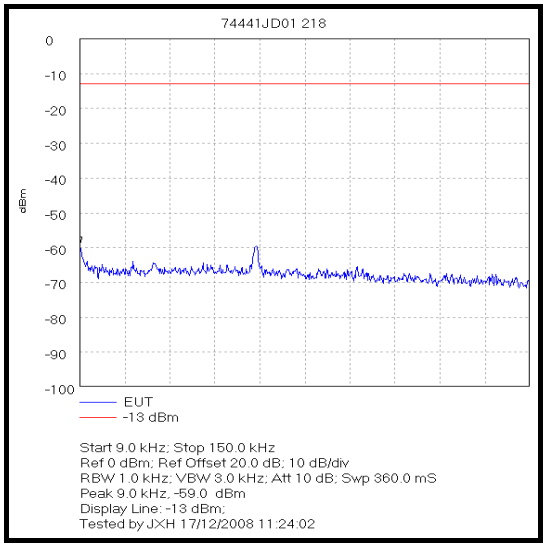
Transmitter Out of Band Conducted Emissions: Section 90.210 (continued) – C4FM (QPSK)

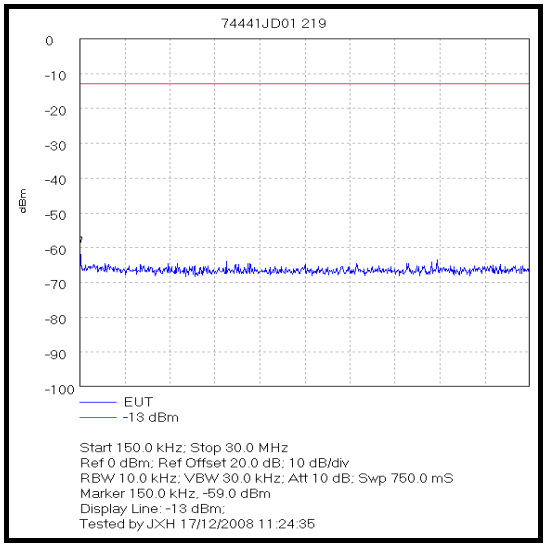


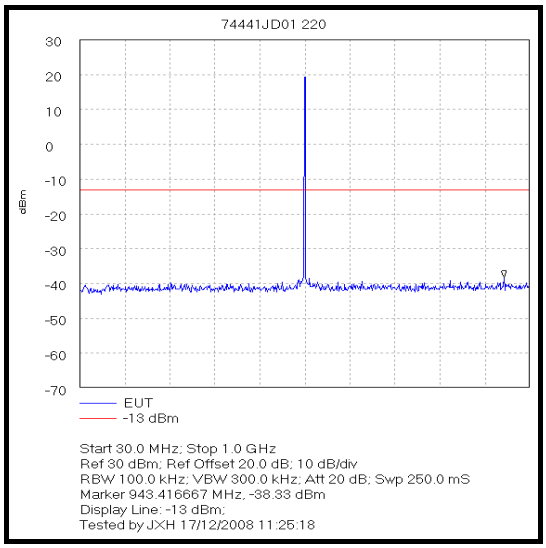


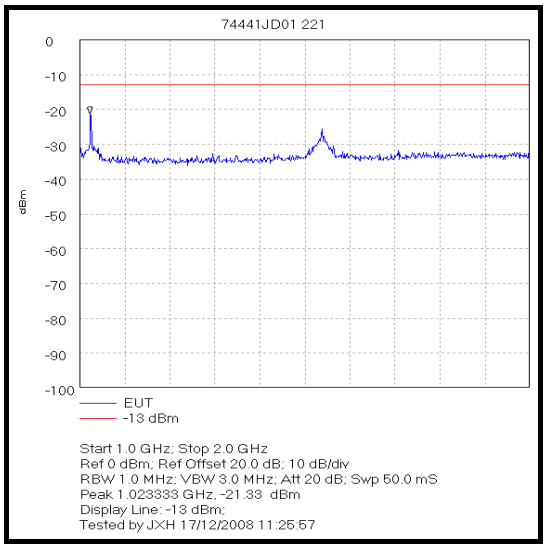
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Out of Band Conducted Emissions: Section 90.210 (continued) – FM (5 kHz)



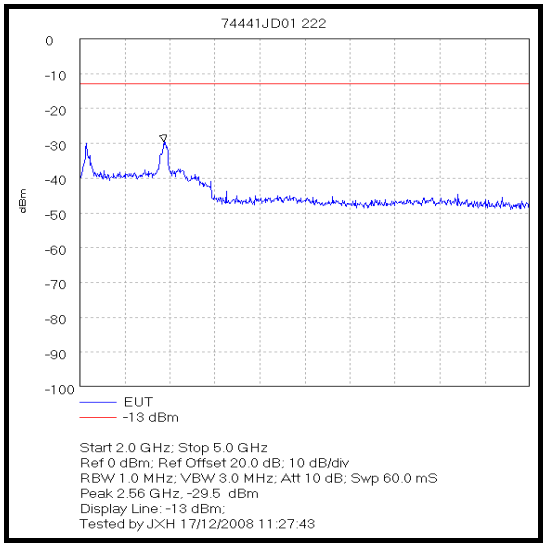


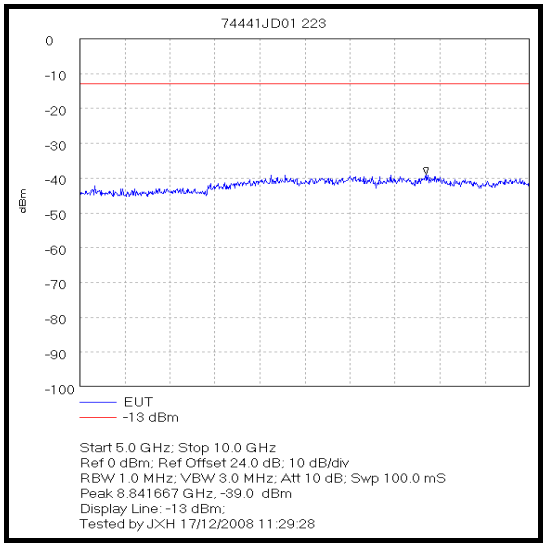


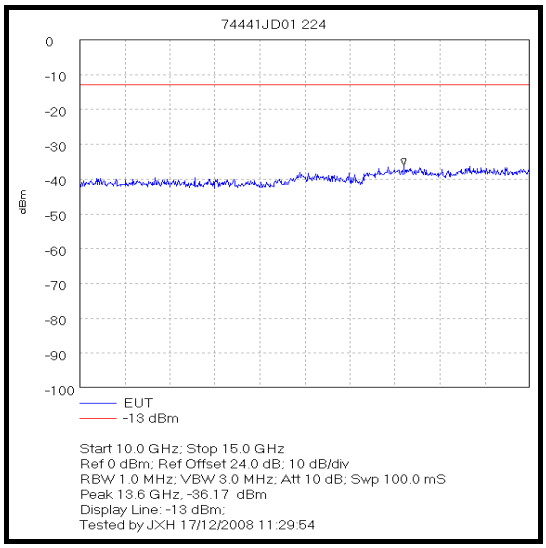


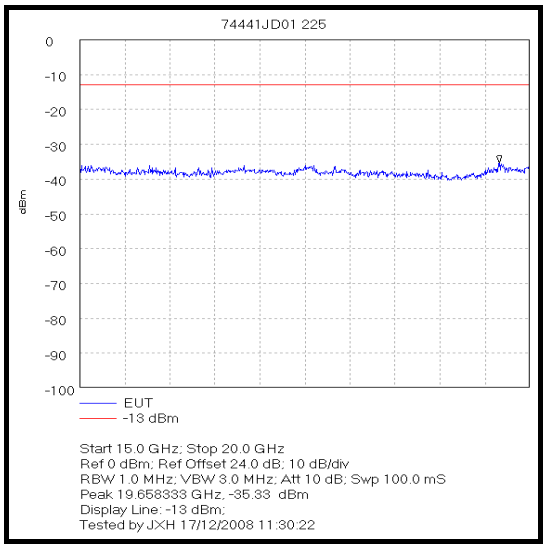
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Out of Band Conducted Emissions: Section 90.210 (continued) – FM (5 kHz)



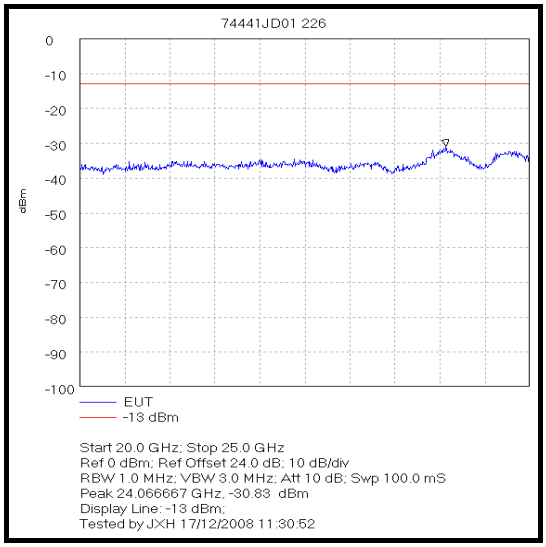


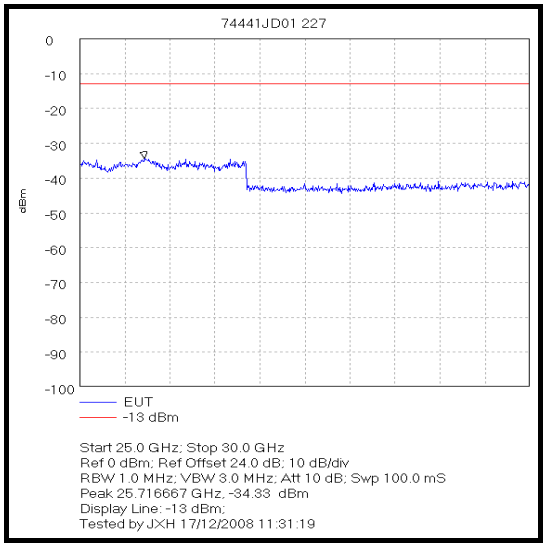




Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Transmitter Out of Band Conducted Emissions: Section 90.210 (continued) – FM (5 kHz)





Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

7.2.9. Transmitter Out of Band Radiated Emissions: Section 90.210

The EUT was configured as for transmitter radiated emission testing as described in section 9 of this report.

Tests were performed to identify the maximum transmitter radiated emission levels.

Results:

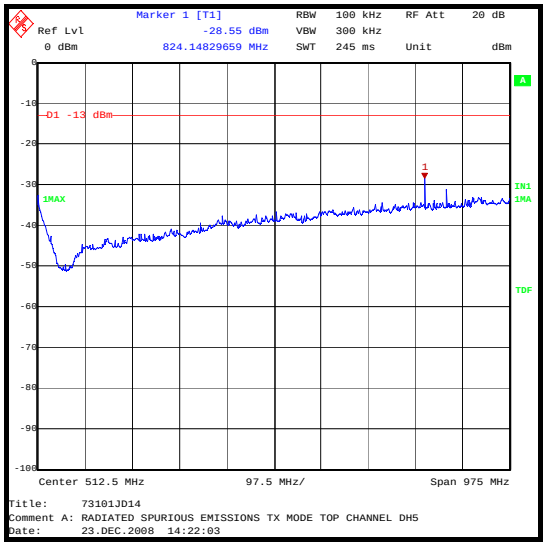
Frequency (MHz)	Peak Emission Level (dBm)	Limit (dBm)	Margin (dB)	Result
17821.142	-36.3	-13.0	23.3	Complied

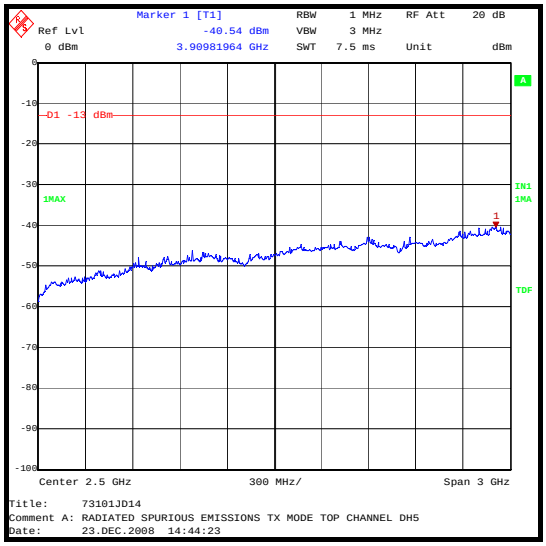
Note(s):

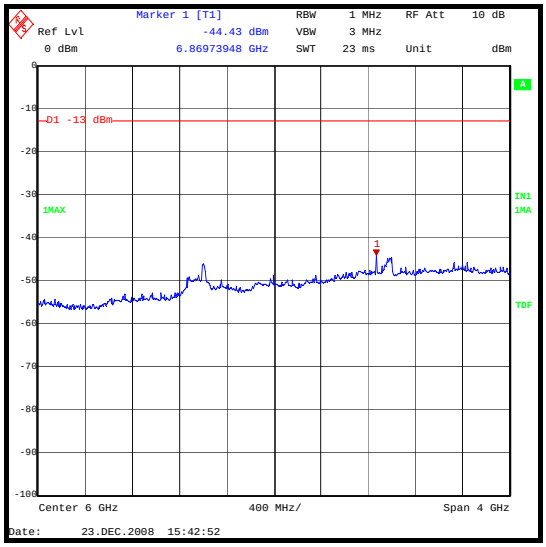
1. *Measurements were performed with the CW signals in the following bands: UHF 406.1 to 454 MHz; UHF 456 to 512 MHz; Public Safe 698 to 824 MHz; Public Safe / SMR / ESMR 851 to 869 MHz*

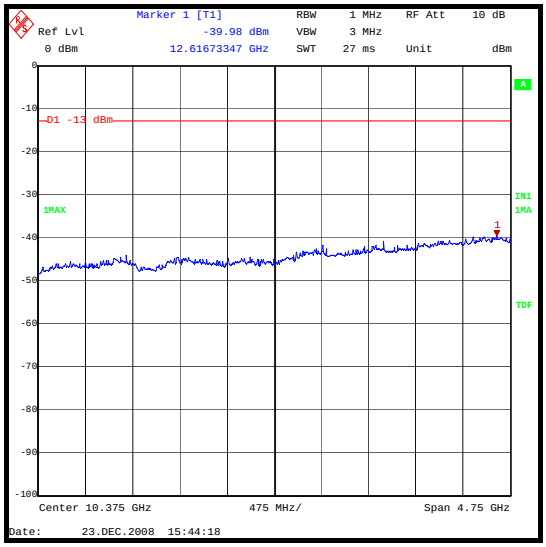
Test of: Zinwave DAS3000
To: FCC Part 90: 2008
Technology - UHF

Transmitter Out of Band Radiated Emissions: Section 90.210 (continued)





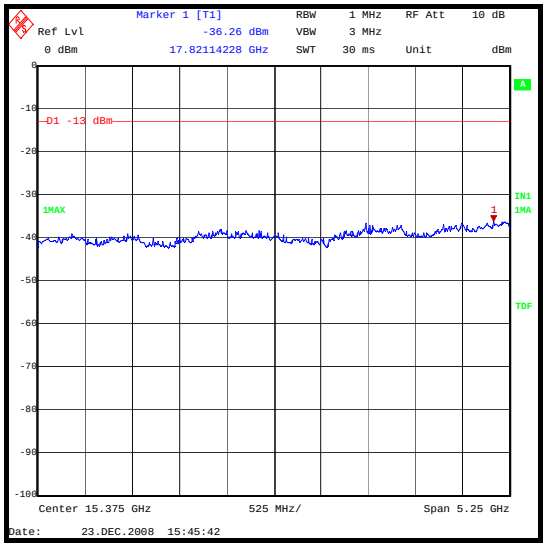


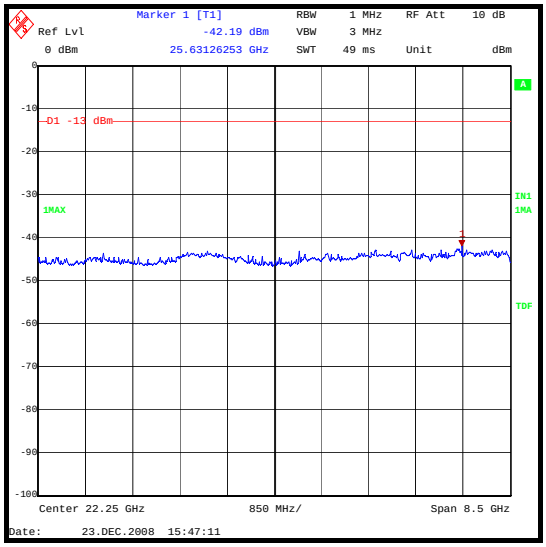


Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

Test of: Zinwave DAS3000
To: FCC Part 90: 2008
Technology - UHF

Transmitter Out of Band Radiated Emissions: Section 90.210 (continued)





Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

8. Measurement Uncertainty

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently, the result of a measurement is only an approximation to the value of the measurand (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor, such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

Measurement Type	Range	Confidence Level (%)	Calculated Uncertainty
AC Conducted Spurious Emissions	0.15 MHz to 30 MHz	95%	±3.72 dB
Carrier Output Power	Not applicable	95%	±0.28 dB
Conducted Emissions	9 kHz to 26 GHz	95%	±0.46 dB
Conducted Emissions Antenna Port	30 MHz to 40 GHz	95%	±0.28 dB
Intermodulation Attenuation	9 kHz to 26 GHz	95%	±0.46 dB
Out of Band Gain	9 kHz to 26 GHz	95%	±0.46 dB
Frequency Stability	Not applicable	95%	±11.4 ppm
Occupied Bandwidth	824 to 849 MHz	95%	±11.4 ppm
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	±4.64 dB
Radiated Spurious Emissions	1 GHz to 26 GHz	95%	±2.94 dB

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty, the published guidance of the appropriate accreditation body is followed.

9. Measurement Methods

9.1. Conducted Output Power

The EUT was connected to a broadband diode detector power sensor via suitable cables and RF attenuators.

An test signal was put at the input of the EUT either via the input port on the service module.

The total loss of the cables, attenuators and combiner were measured and entered as a offset into the power meter.

The EUT was set to the required channel and the transmitter set to operate at full power.

The corrected maximum value was displayed on the power meter and the conducted power level was recorded.

9.2. Frequency Stability

The EUT was situated within an environmental test chamber and connected directly to the measurement receiver an access port.

Measurements were performed with the EUT operating under extremes of temperature in 10 degree increments within the range -30 to 50 ºC.

Measurements were also performed at voltage extremes between the declared nominal supply voltage and at the declared endpoint voltage (for hand carried battery operated equipment) or by varying the primary supply voltage from 85% to 115% of the nominal value for all other equipment types.

The requirement was to determine the frequency stability of the device under specified environmental operating conditions.

The EUT was switched off for a minimum of 30 minutes between each stage of testing while the environmental chamber stabilised at the next temperature within the stated temperature range.

The frequency error measured was converted to an error in ppm using the following formula as defined by TIA_EIA_603A:-

$$\text{ppm error} = \left(\frac{MCF_{MHz}}{ACF_{MHz}} - 1\right) * 10^6$$

where MCF_{MHz} is the measured carrier frequency in MHz
ACF_{MHz} is the assigned carrier frequency in MHz

The measured ppm had to be less then the relevant limits in order to comply.

9.3. Occupied Bandwidth

The EUT was connected to a spectrum analyser enabled with an occupied bandwidth function and a signal generator connected to the input port on the service module.

Measurements were performed to determine that the occupied bandwidth did not alter when being passed through the EUT. Occupied bandwidth measurements were performed in accordance with FCC Part 2.1049.

The occupied bandwidth was measured using the built in occupied bandwidth function of the Rohde and Schwarz FSEB or ESIB spectrum analyser. It was set to measure the bandwidth where 99% of the signal power was contained. The analyser settings were set as per those outlined in the spectrum analyser user manual for this measurement, i.e., RBW $\geq$ 1% of occupied bandwidth.

The test was performed twice for each modulation scheme being tested. The first test was to show the input signal of the specific technology being tested. Then the test was repeated with the input signal fed through the system and recorded at the antenna port. A comparison between input and output was made and the verdict recorded.

9.4. Transmitter Conducted Emissions Measurements

Spurious emission measurements at the antenna port were performed from the lowest declared frequency to 10 times the highest EUT fundamental frequency.

A measuring receiver was connected to the antenna port of the EUT via a suitable cable and RF attenuator. The total loss of both the cable and the attenuator were measured and entered as a reference level offset into the measuring receiver to correct for the losses.

The limit in the standard states that emissions shall be attenuated by at least 43+10 log (P) dB below the transmitter power (P), where (P) is the maximum measured fundamental power for the channel under test. This limit always reduces to -13 dBm therefore, the limit line presented on the accompanying plots is set to -13 dBm.

The frequency band described above was investigated with the transmitter operating at full power. Any spurious observed were then recorded and compared to the -13 dBm limit. The requirement is for the emission to be less than -13 dBm. The margin between emission and limit is recorded and should always be positive to indicate compliance.

The test equipment settings for conducted antenna port measurements were as follows:

Receiver Function	Settings
Detector Type:	Peak
Mode:	Max Hold
Bandwidth:	100 kHz >1 GHz
Bandwidth:	10 kHz <1 GHz
Amplitude Range:	100 dB
Step Size:	Continuous sweep
Sweep Time:	Coupled

The resolution bandwidth used for measurements in the 1 MHz blocks either side of the declared operating frequency block were set as described in the procedure above.

9.5. AC Mains Conducted Emissions

AC mains conducted emission measurements were performed in accordance with the standard, against appropriate limits for each detector function.

The test was performed in a shielded enclosure with the equipment arranged as detailed in the standard on a wooden bench using the floor of the screened enclosure as the ground reference plane. The EUT was powered with 110V 60 Hz AC mains supplied via a line impedance stabilisation network (LISN).

Initial measurements in the form of swept scans covering the entire measurement band were performed in order to identify frequencies on which the EUT was generating interference. In order to minimise the time taken for these swept measurements, a peak detector was used in conjunction with the appropriate detector IF measuring bandwidths (see table below). Repetitive scans were performed to allow for emissions with low repetition rates, and the duty cycle of the EUT. The test configuration was the same for the initial scans as for the final measurements.

Following the initial scans, a graph was produced giving an overview of the emissions from the EUT plotted against the appropriate specification limit. A tolerance line was set 6 dB below the specification limit and levels above the tolerance line were re-tested (at individual frequencies) using the appropriate detector function.

The test equipment settings for conducted emissions measurements were as follows:

Receiver Function	Initial Scan	Final Measurements
Detector Type:	Peak	Quasi-Peak (CISPR)/Average
Mode:	Max Hold	Not applicable
Bandwidth:	10 kHz	9 kHz
Amplitude Range:	60 dB	20 dB
Measurement Time:	Not applicable	> 1 s
Observation Time:	Not applicable	> 15 s
Step Size:	Continuous sweep	Not applicable
Sweep Time:	Coupled	Not applicable

9.6. Transmitter Radiated Emissions

Radiated emission measurements were performed in accordance with the standard, against appropriate limits for each detector function.

Initial pre-scans covering the entire measurement band from the lowest generated frequency declared up to 10 times the highest fundamental frequency. The scans were performed within a screened chamber in order to identify frequencies on which the EUT was generating spurious. This procedure identified the frequencies from the EUT, which required further examination. Repetitive scans were performed to allow for emissions with low repetition rates, and for the duty cycle of the EUT.

The initial scans were performed using an antenna height of 1.5 m and a measurement distance of 3 m. A limit line was set to the specification limit by characterising the screen room using a known signal source set at exactly the same location as the EUT. The signal source was derived from either a horn antenna or a dipole dependant on the frequency band under investigation. Any levels within 20 dB of this limit were measured where possible, on occasion; the receiver noise floor came within the 20 dB boundary. On these occasions, the system noise floor may have been recorded.

The levels were maximised by initially rotating the turntable through 360° and then varying the antenna height between 1 m and 4 m in the vertical polarisation. At this point, any signals found to be between the limit and a level 6 dB below it were further maximised by changing the configuration of the EUT, e.g. re-routing cables to peripherals and moving peripherals with respect to the EUT. The procedure was repeated for the horizontal polarisation.

Once the final amplitude (maximised) had been obtained, the EUT was substituted with a substitution antenna. For EIRP measurements a horn antenna whose gain was based on an isotropic antenna was used, ERP measurements were done using a dipole. The centre of the substitution antenna was set to approximately the same centre location as the EUT. The substitution antenna was set to the horizontal polarity. The substitution antenna was matched into a signal generator using a 6 dB or greater attenuator. The signal generator was tuned to the EUT's frequency under test.

The test antenna was then raised and lowered to obtain a maximum reading on the spectrum analyser. The level of the signal generator output was then adjusted until the maximum recorded EUT level was observed. The signal generator level was noted. This procedure was repeated with both test antenna and substitution antenna vertically polarised. The radiated power was calculated as:-

EIRP/ERP = Signal Generator Level - Cable Loss + Antenna Gain

The limit in the standard states that emissions shall be attenuated by at least 43+10 log (P) dB below the transmitter power (P), where (P) is the maximum measured fundamental power for the channel under test. This limit always reduces to -13dBm therefore, the limit line presented on the accompanying plots is set to -13dBm.

Any spurious measured were then compared to the -13dBm limit. The requirement is for the emission to be less than -13dBm. The margin between emission and limit is recorded and should always be positive to indicate compliance.

Appendix 1. Test Equipment Used

RFI No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval (Months)
A1299	Antenna	Schaffner	CBL6143	5094	28 Jul 2008	12
A1534	Pre Amplifier	Hewlett Packard	8449B OPT H02	3008A00405	Calibrated before use	12
A1737	Attenuator	Atlantic Microwave	BBS40-20	R4722	Calibrated before use	12
A1818	Antenna	EMCO	3115	00075692	25 Oct 2008	12
C1069	Cable	Rosenberger	FB311A1050M5050	2302 26382-1	20 Apr 2008	12
C1088	Cable	Rosenberger	FA210A1050005050	1	20 Apr 2008	12
C1164	Cable	Rosenberger Micro-Coax	FA210A1015007070	43188-1	Calibrated before use	12
C499	Cable	Rosenberger	FA210A1020M30309	001	Calibrated before use	12
E0513	Environmental Chamber	TAS	LT600 Series 3	23900506	Calibration not required	12
G085	Continuous Wave Generator	Hewlett Packard	83650L	3614A00104	27 Oct 2008	24
M1124	Spectrum Analyser	Rohde & Schwarz	ESIB26	100046K	19 Feb 2008	12
M1249	Thermometer	Fluke	52II	88800049	09 Jul 2008	12
M1251	Digital Multimeter	Fluke	175	89170179	21 Dec 2007	12
M1253	Spectrum Analyser	HP	8564E	3442A00262	21 Oct 2008	12
M127	Spectrum Analyser	Rohde & Schwarz	FSEB 30	842 659/016	21 Aug 2008	12
M1348	Network Analyser Display	Agilent	8757E	3025A00346	26 Jun 2008	12
M1349	Network Analyser Detector	Agilent	85025D	01447	06 Jun 2008	12
M1449	SMIQ03B	Rohde and Schwarz	SMIQ03B	100176	23 Jan 2008	12

RFI No.	Instrument	Manufacturer	Type No.	Serial No.	Date Last Calibrated	Cal. Interval (Months)
M1480	Power Splitter	Agilent	11667C	52003	Calibrated as part of system	12
M1501	Network Analyser 50GHz Sensor	Hewlett Packard	85025D	US38012297	28 Jun 2008	12
M166	Thermometer/Barometer/ Hygrometer	EuroCom	None	None	18 Jun 2008	12
M259	SME03 Signal Generator	Rohde & Schwarz	1038.60 02.03	827758/021	Calibrated before use	12
M281	Power Meter	Hewlett Packard	E4418A (EPM44 1A)	GB37170210-01	23 Oct 2008	12
M283	Power Sensor	Hewlett Packard	8487A	3318A03241	27 Oct 2008	12

NB In accordance with UKAS requirements, all the measurement equipment is on a calibration schedule.